

# BRAHMS measurements in pp 62.4 and 200 GeV.

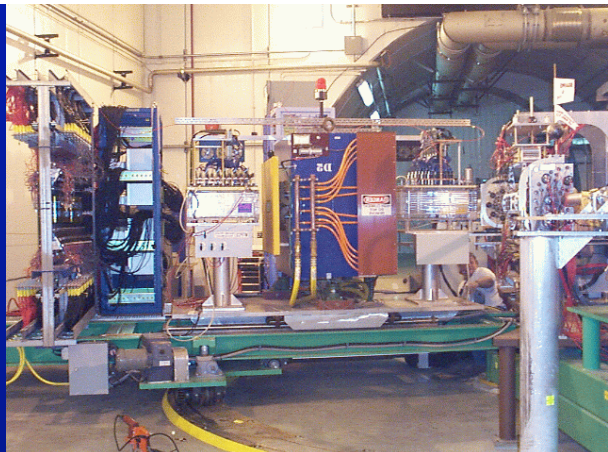
F.Videbaek  
BNL

# pp at RHIC

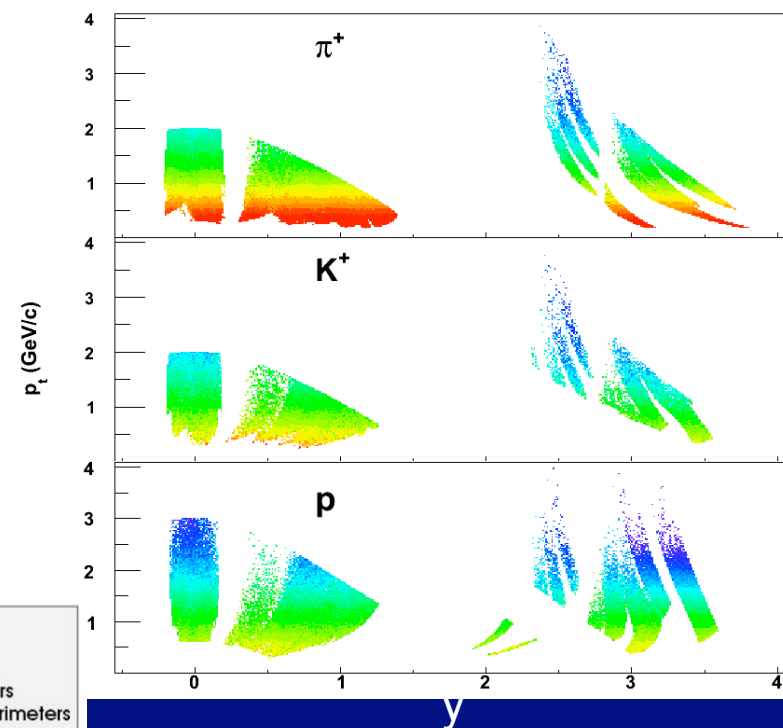
- The pp measurements at RHIC has had two distinct goals.
  - Reference data for Heavy Ion Collisions
  - Longitudinal and transverse Spin measurements.
- BRAHMS has taken pp reference and transverse spin data at 200 and 62.4 GeV
- (run-2, run-3, **run-5, run-6**)
- The latter 2 contains the bulk of data.
- I like to put these data in perspective how they may be useful for tuning models to underlying event. (I just learned of the MCnet a few days ago)
- In particular we have looked at NLO pQCD with W.,Vogelsang, and some default PYTHIA (6.4) comparisons.
- **NOTE: Even though not labeled as such much data plots should be considered preliminary. A publication is in preparation, but until submitted the data are preliminary.**

# Observations

- The RHIC pp data has order magnitude better statistics than earlier measurements at ISR, and in p+pbar at CERN (UAx-exp).
- They thus provide a good testing ground for theoretical interpretations and descriptions.

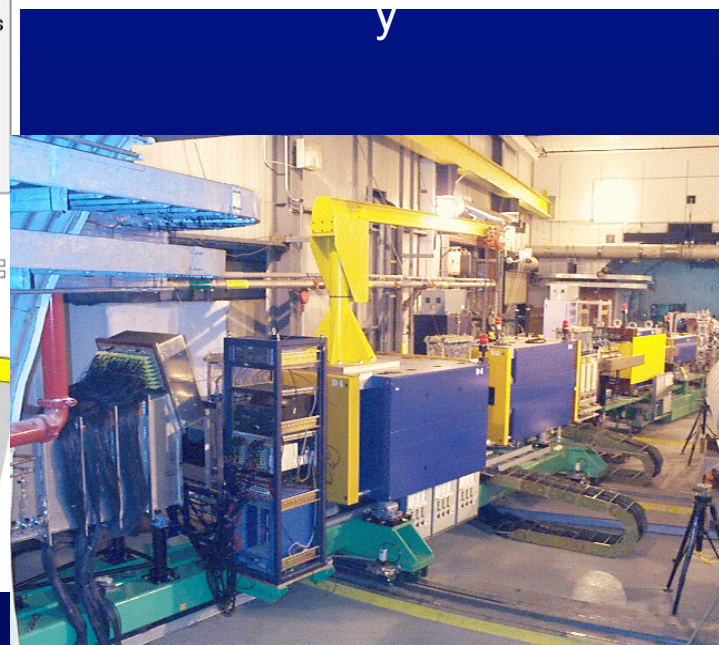
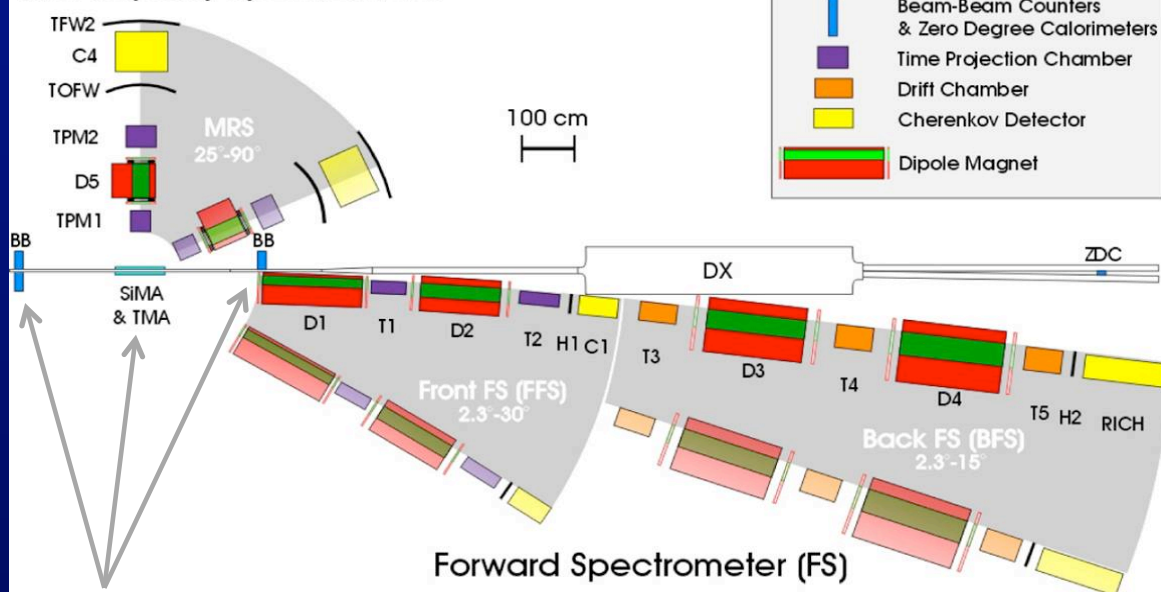


200 GeV



## BRAHMS Experimental Setup

### Mid Rapidity Spectrometer



Global  
Detectors

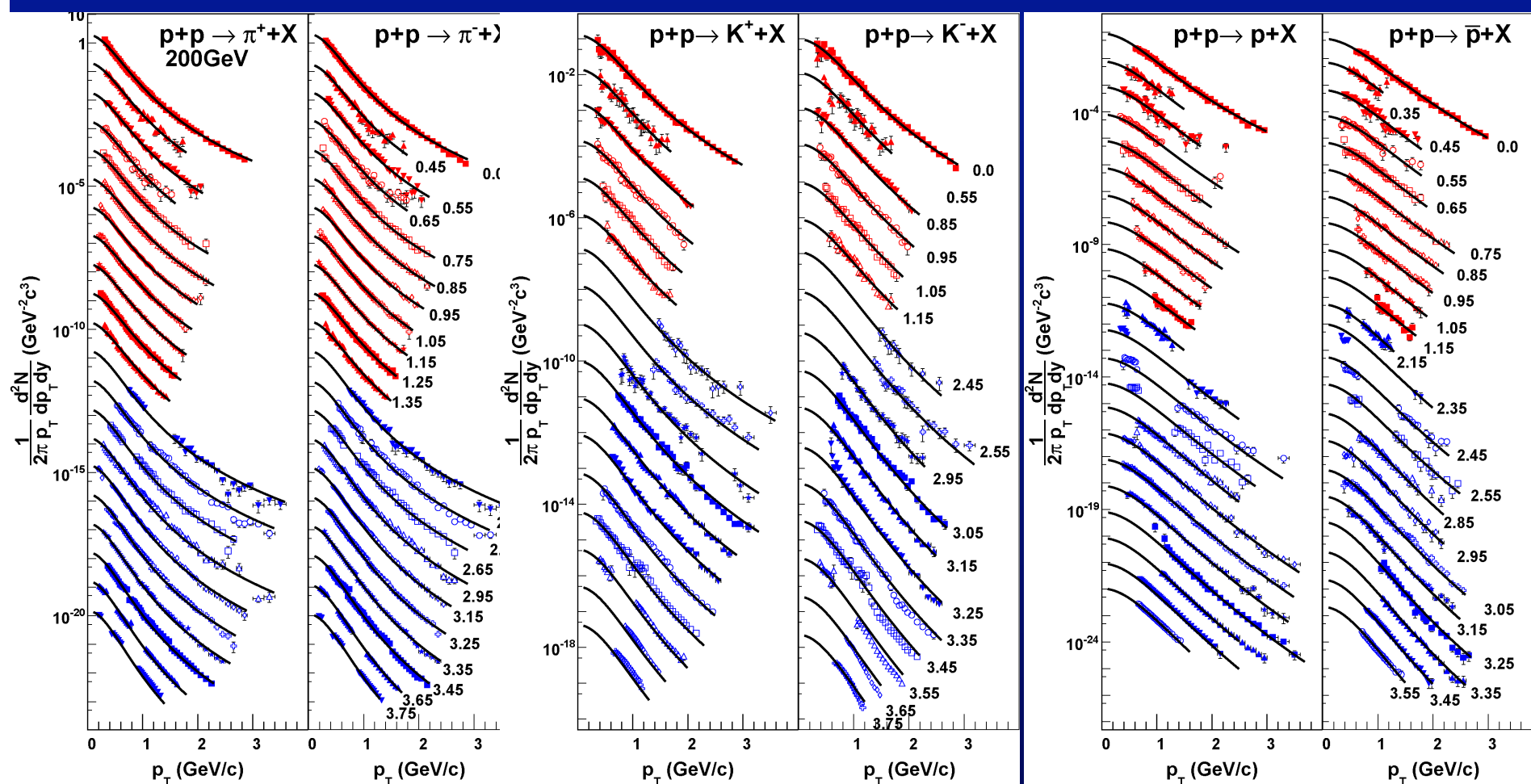
Front Forward  
Spectrometer

Back Forward  
Spectrometer

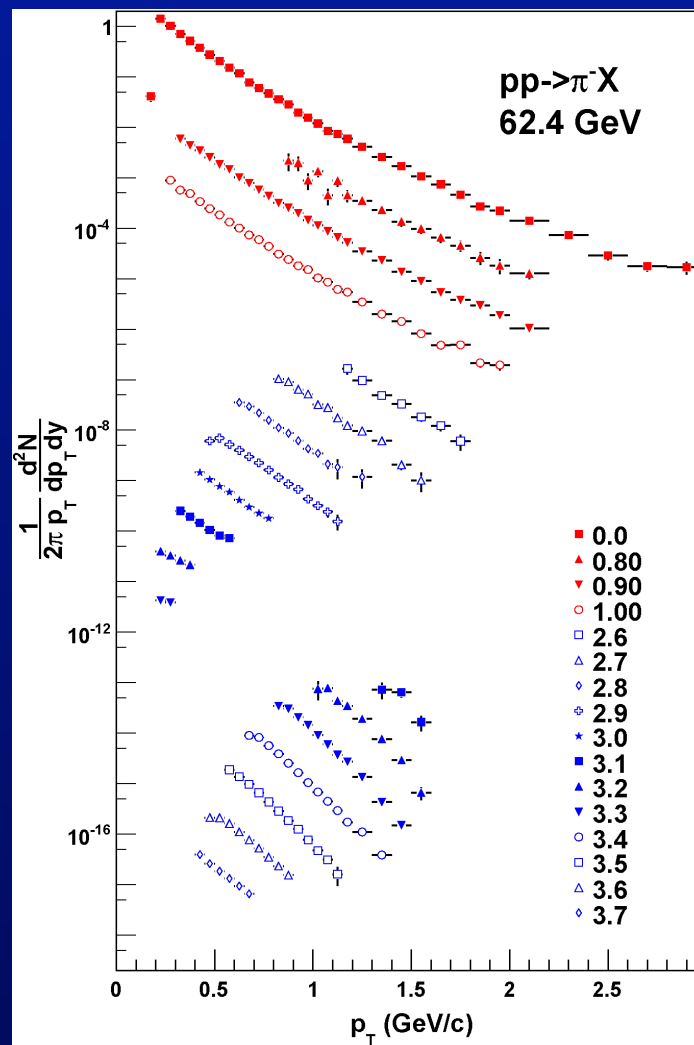
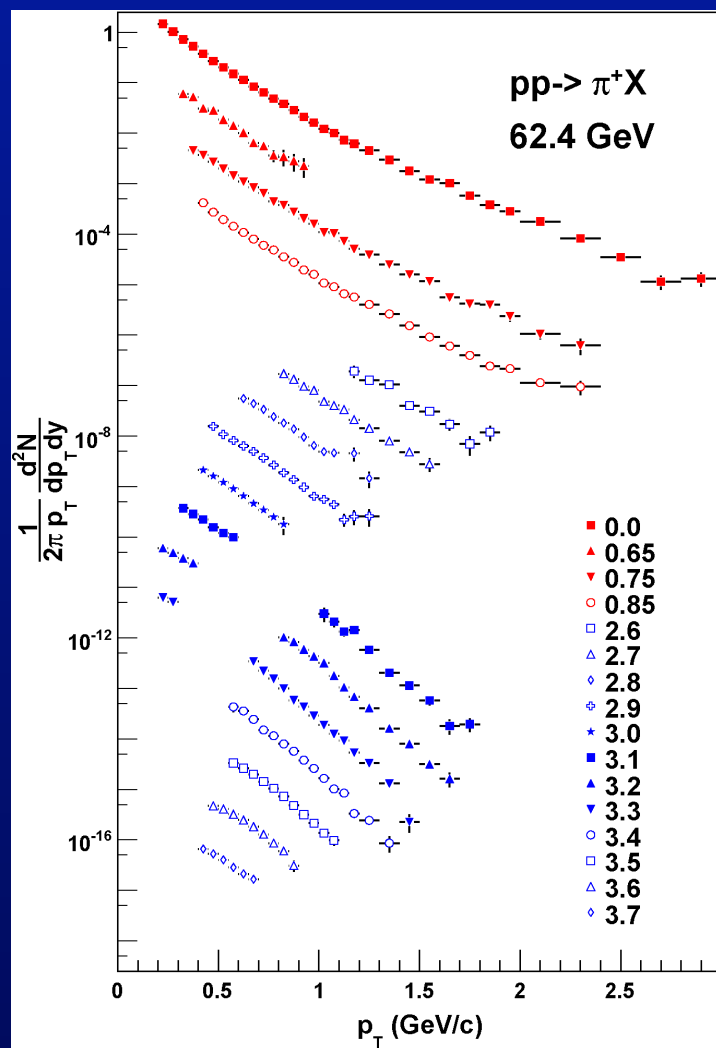
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# 200 GeV spectra

## $y_b = 5.4$

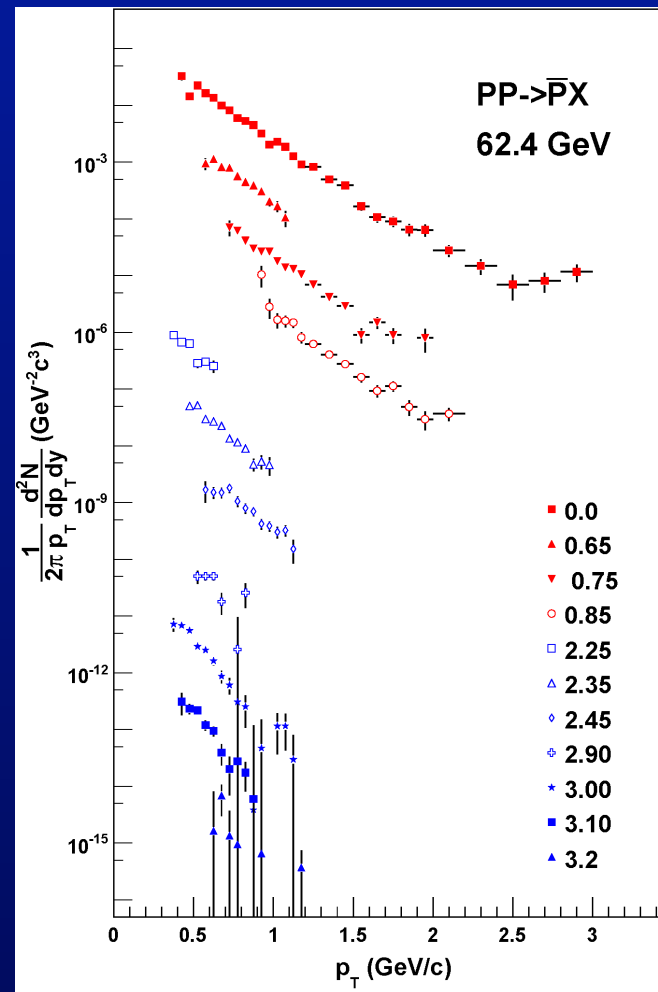
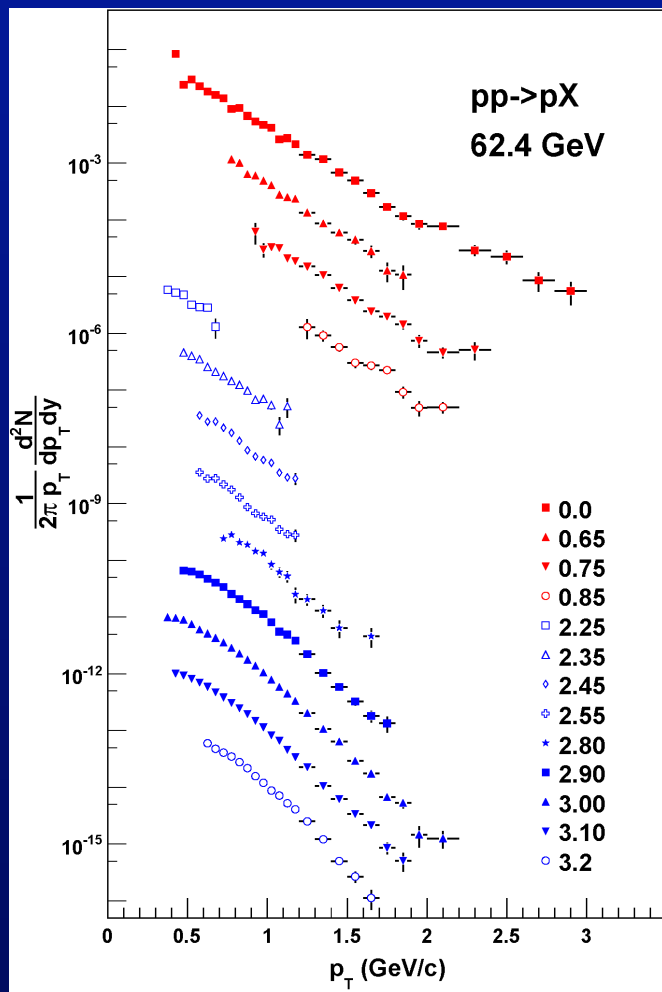


# 62 GeV pions; $y_b=4.2$



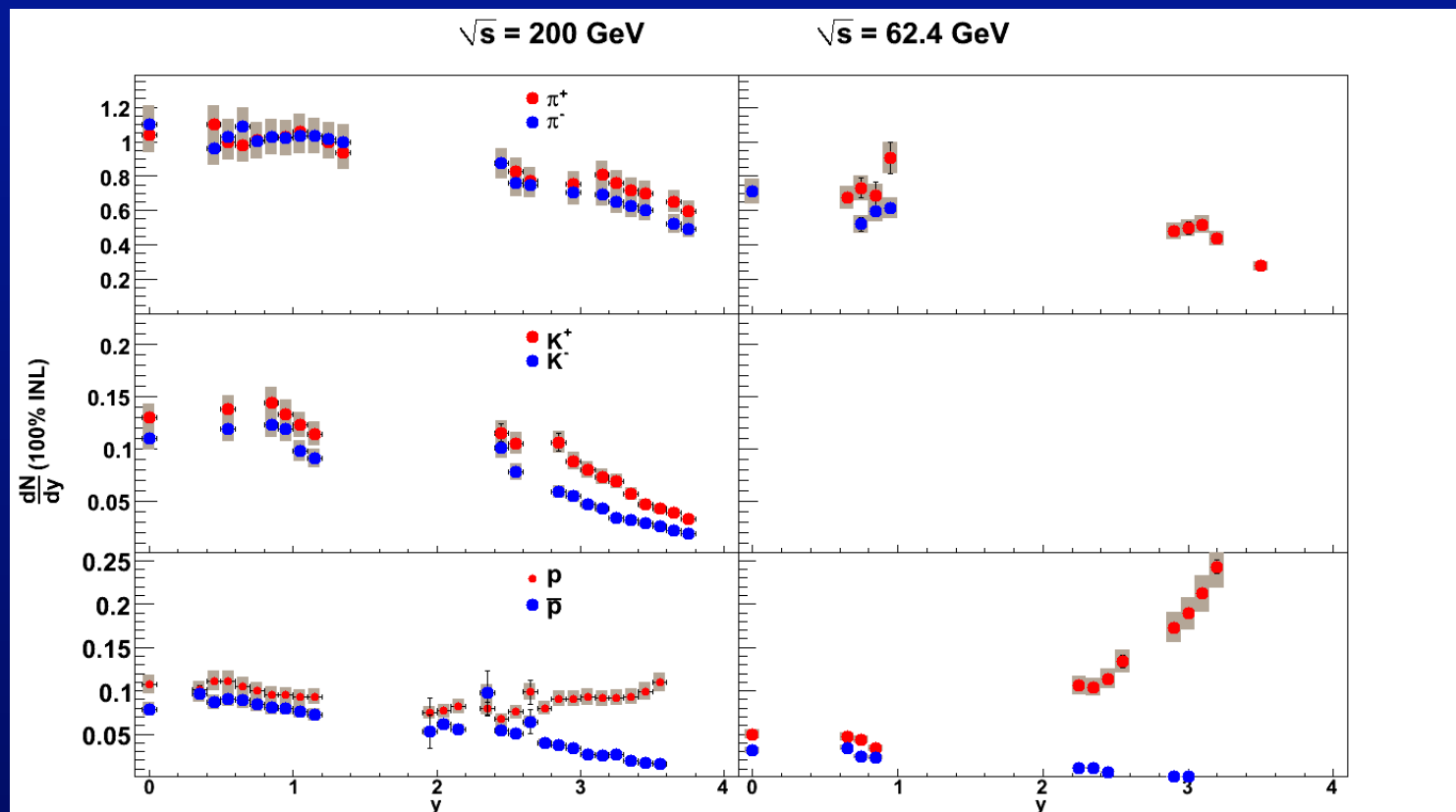
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# 62 GeV protons



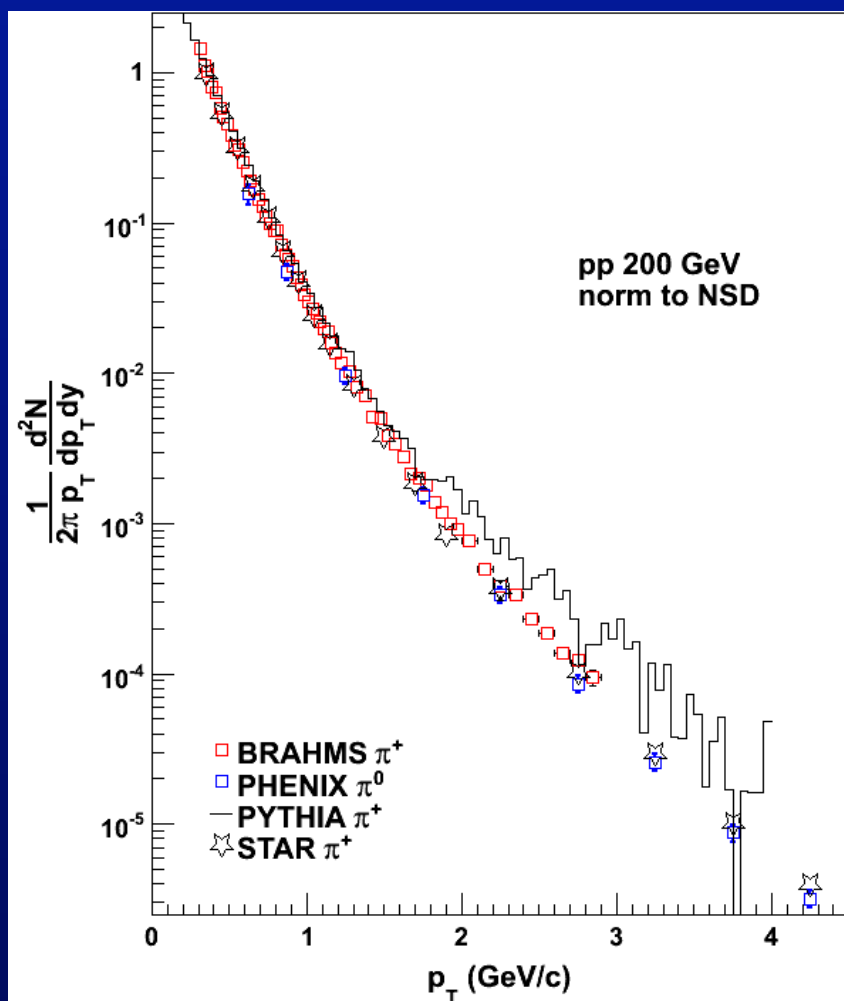


# Extracted $dN/dy$ (norm to total inel. Cross section)



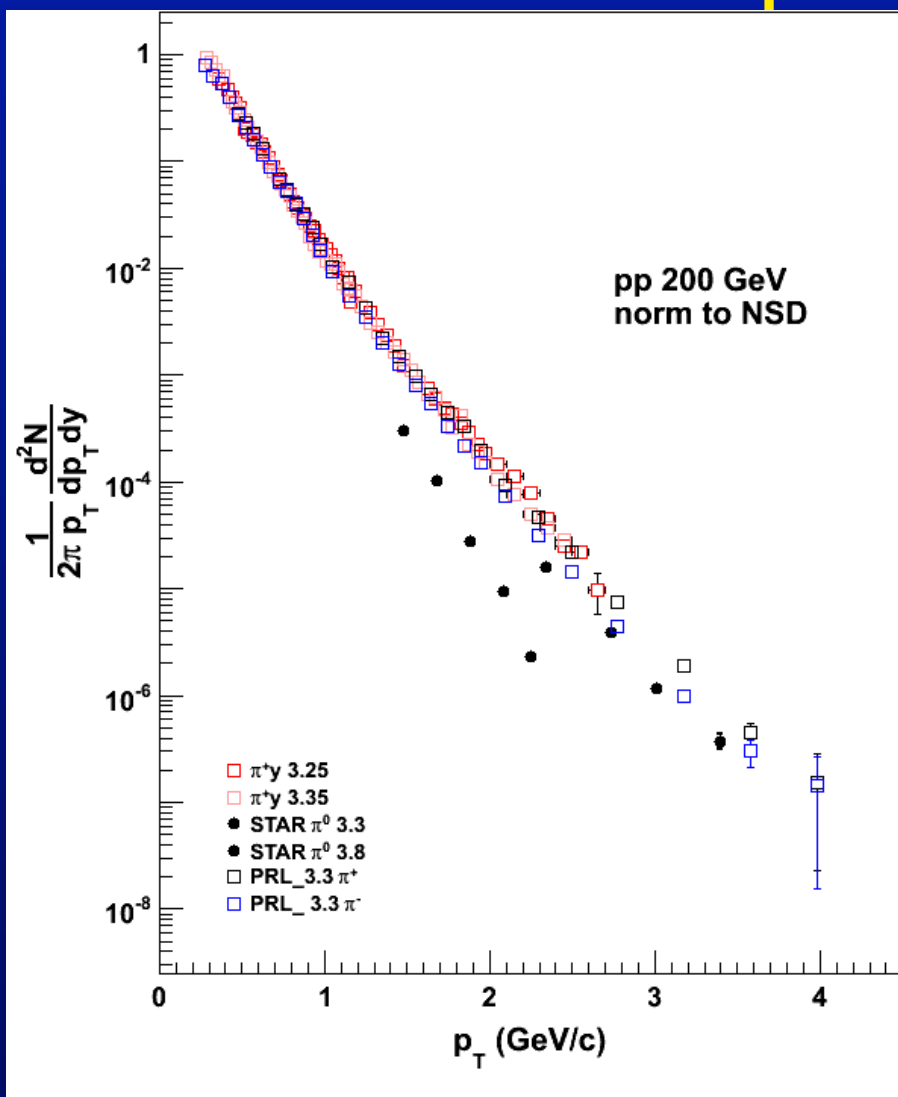


# Y~0 pp 200



- Data compares well between experiments. Pythia 6.4. above data at higher pt. (In contrast to 6.2 which were below (STAR ref.)

# Comparisons

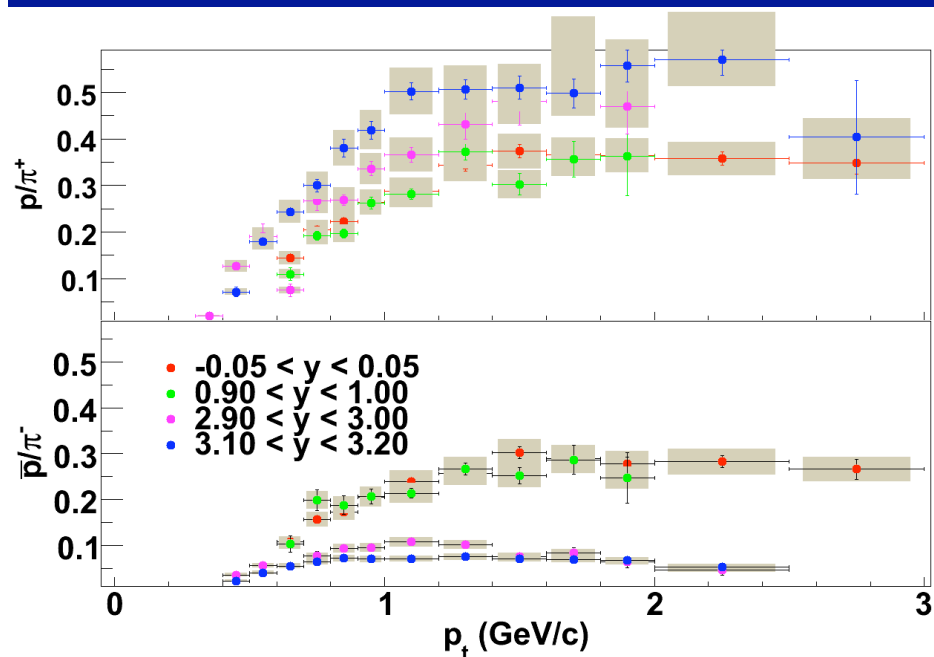


High rapidity pi comparisons.  
BRAHMS/STAR data.  
Both sets have been used in  
Global analysis by DeFlorian et  
al.

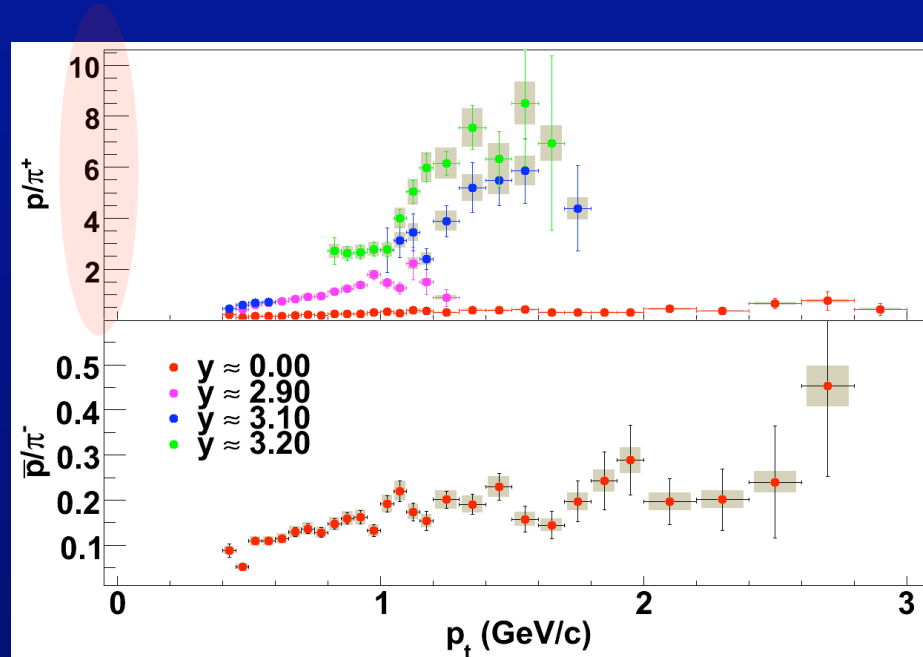
They do not quite seem to  
agree though. I do not know  
why.

# $p/\pi$ Ratios

200 GeV



62 GeV



- $p/\pi^+$  increases in general with rapidity
- $\bar{p}/\pi^-$  decreases with rapidity
- $p_t$  dependence of  $p/\pi^+$  at lower energy much stronger
- Rapidity dependence at lower energy much stronger.
  - Result of proximity to beam rapidity

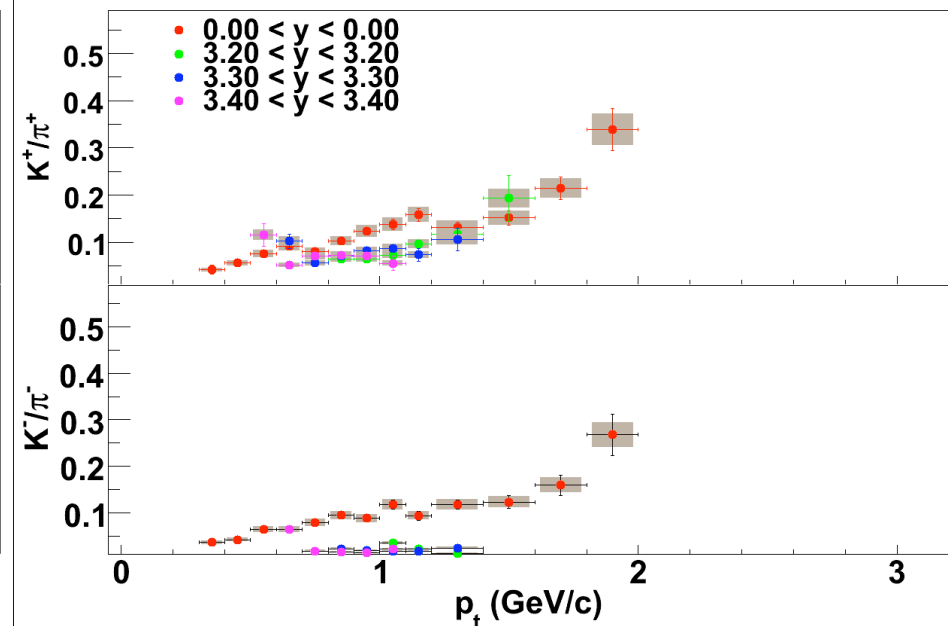
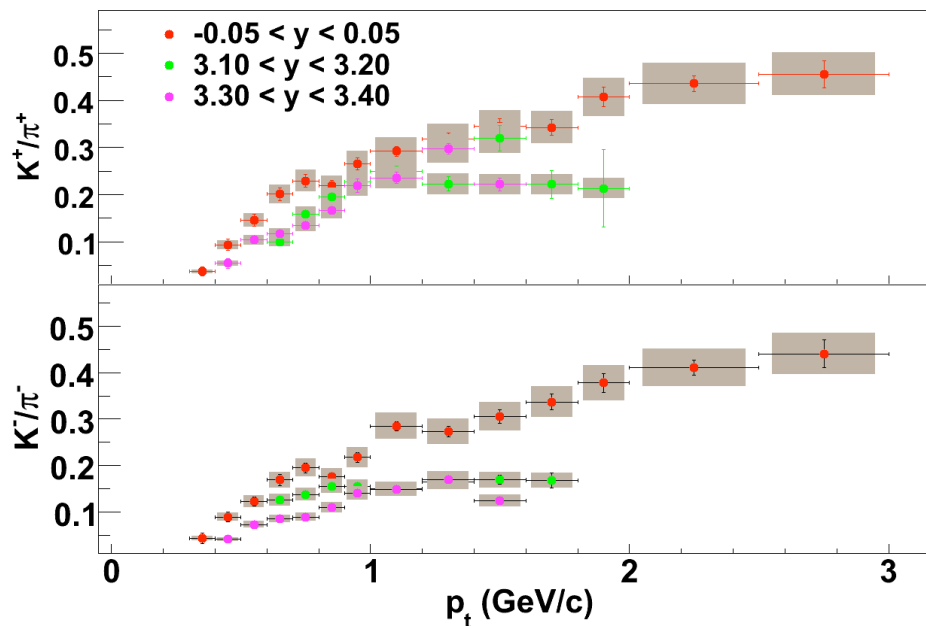
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# $K/\pi$ Ratios



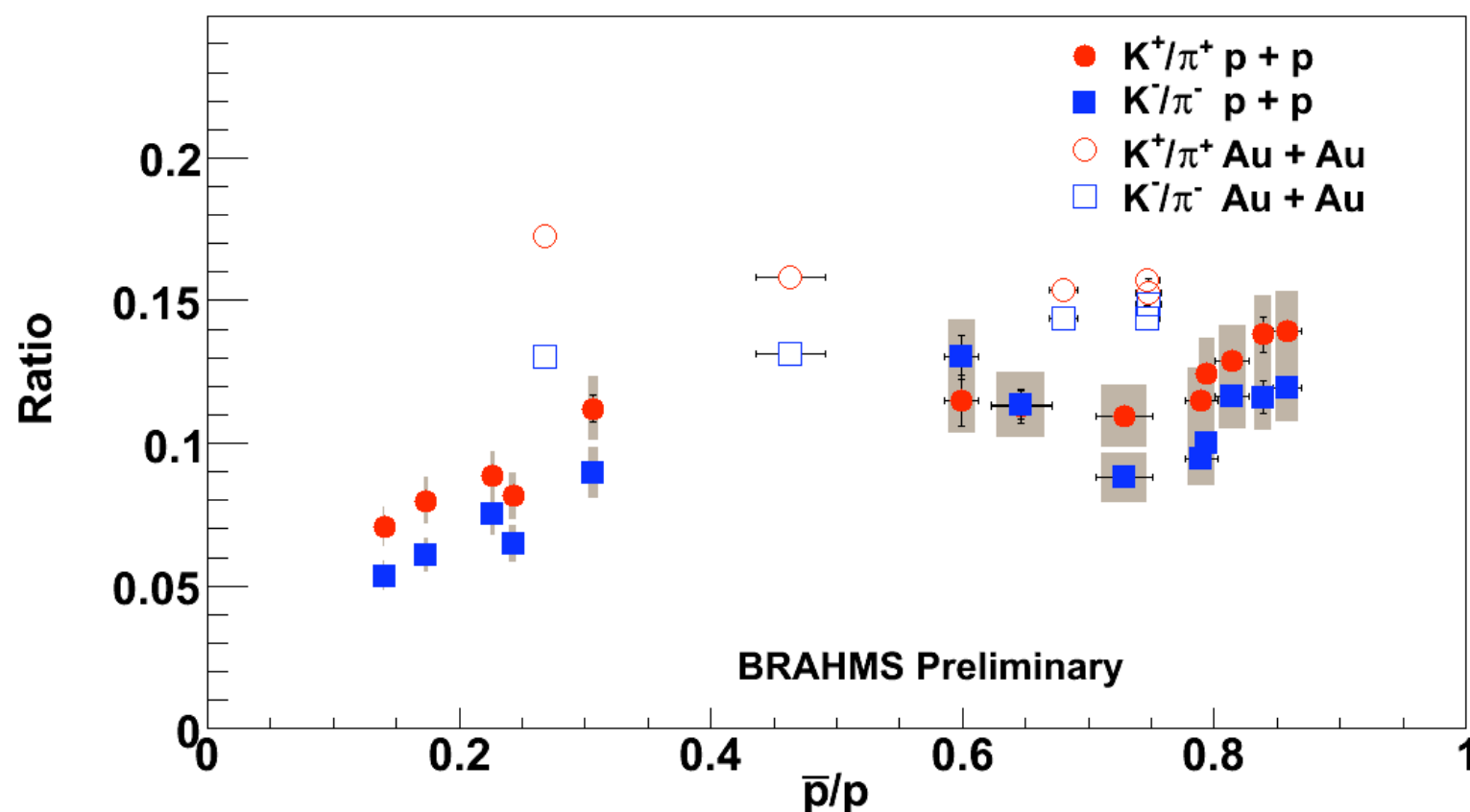
200 GeV

62 GeV



- $K^+/\pi^+$  and  $K^-/\pi^-$  decrease with rapidity at both energies
- Lower values at 62 GeV compared to 200 GeV

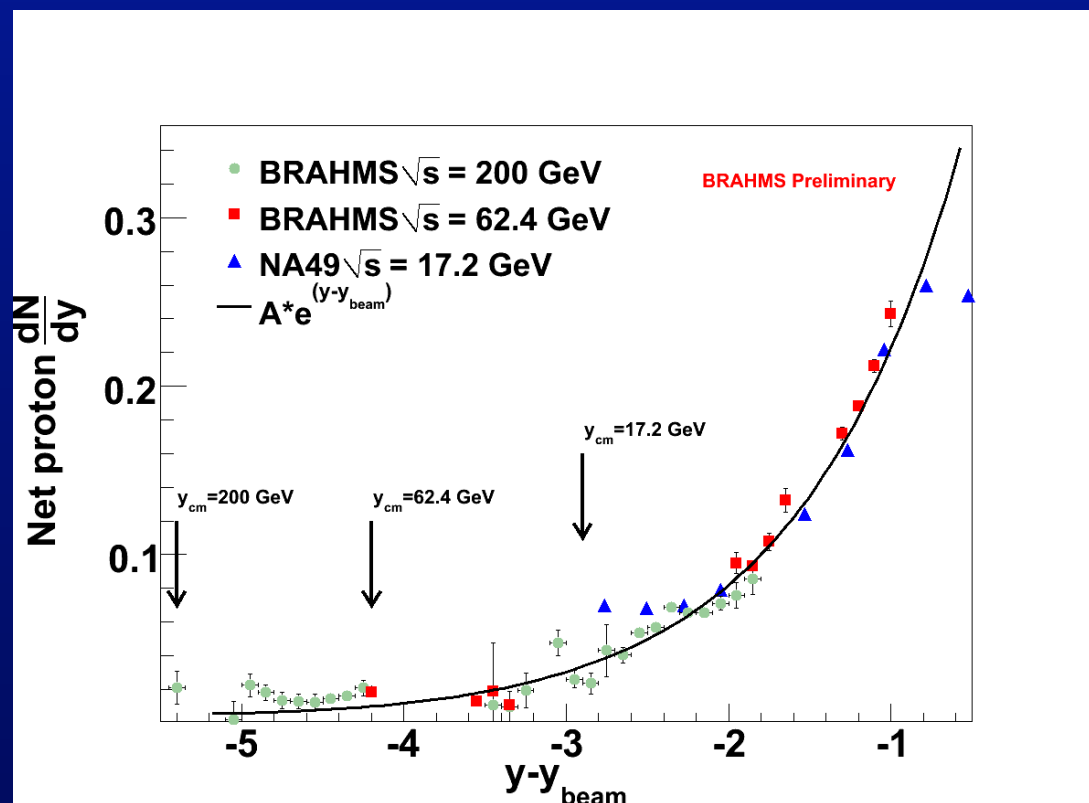
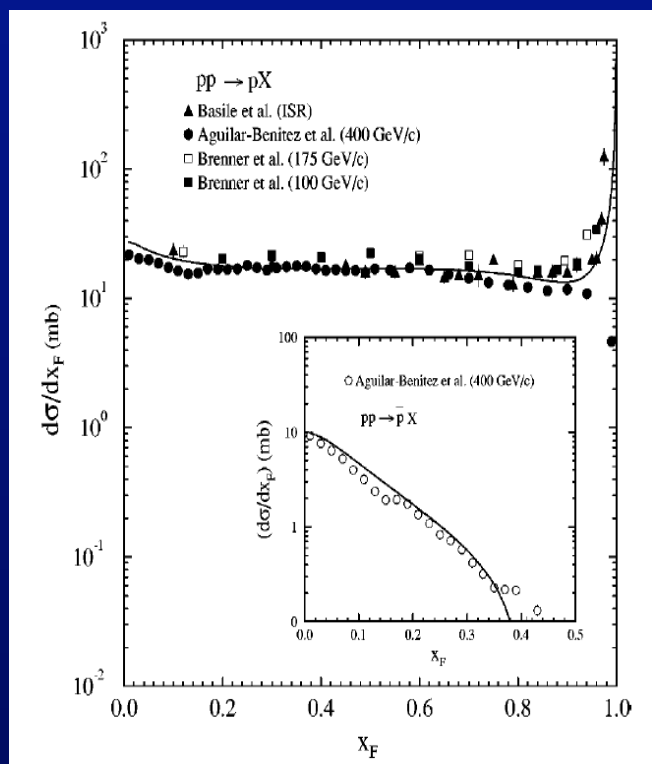
# K/ $\pi$ vs baryochemical potential



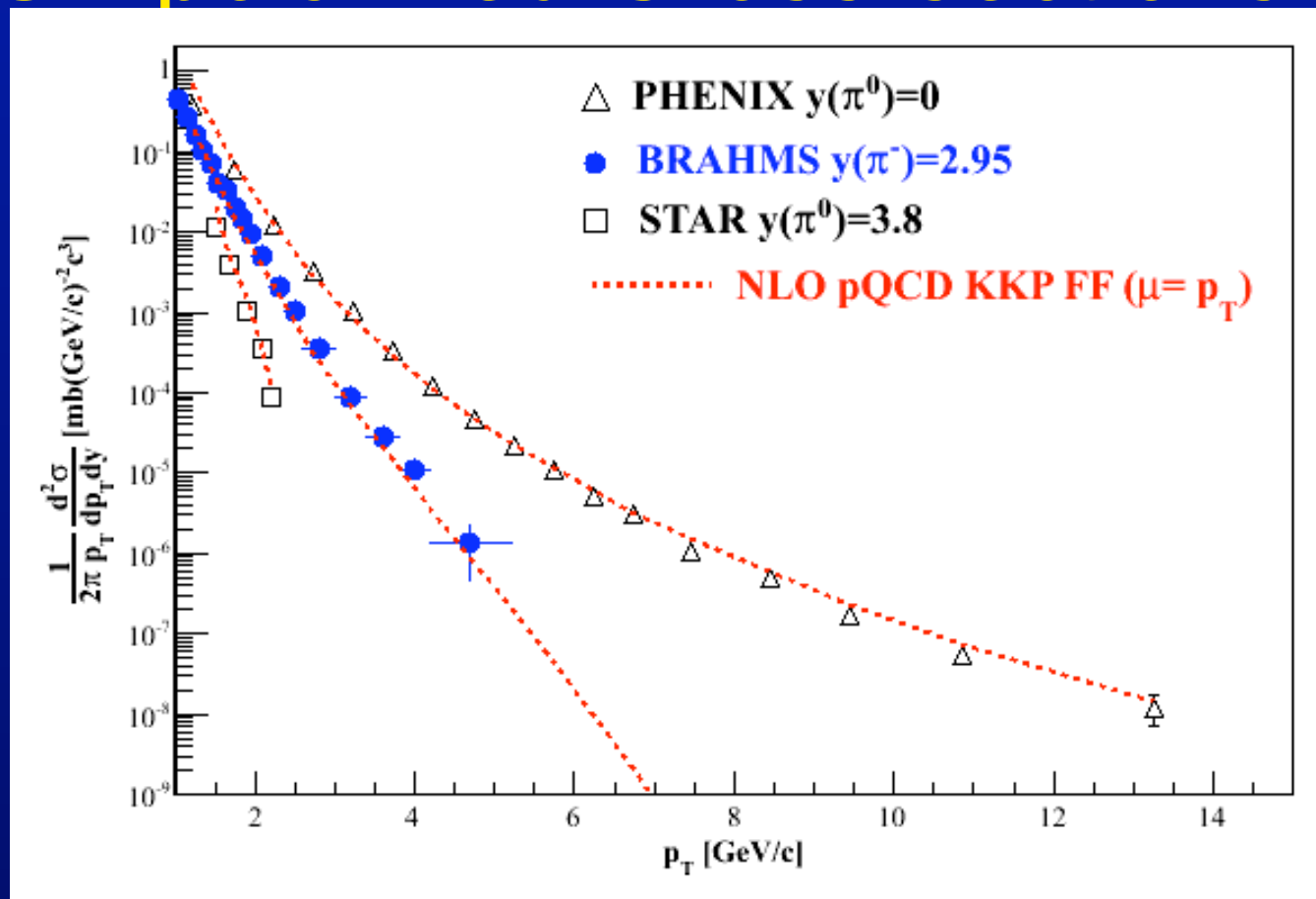
- $K^+/\pi^+$  and  $K^-/\pi^-$  increase with  $\bar{p}/p$  (inverse  $y$  scale)
- Near values for Au + Au for large  $\bar{p}/p$  (mid rapidity)

# Scaling in pp

- pp collision at lower energies exhibits a feature where  $dN/dx \sim \text{constant}$  with an integral of  $\sim 0.6-0.7$
- This implies for constant  $\langle m_T \rangle$  vs. rapidity that  $dN/dy \sim \exp(-y)$
- The present data confirms this behavior at 200 GeV. I think one can safely conclude that the constant behaviour is observed up to RHIC energies.
- I know this is in contrast to PYTHIA (do not have plot here)



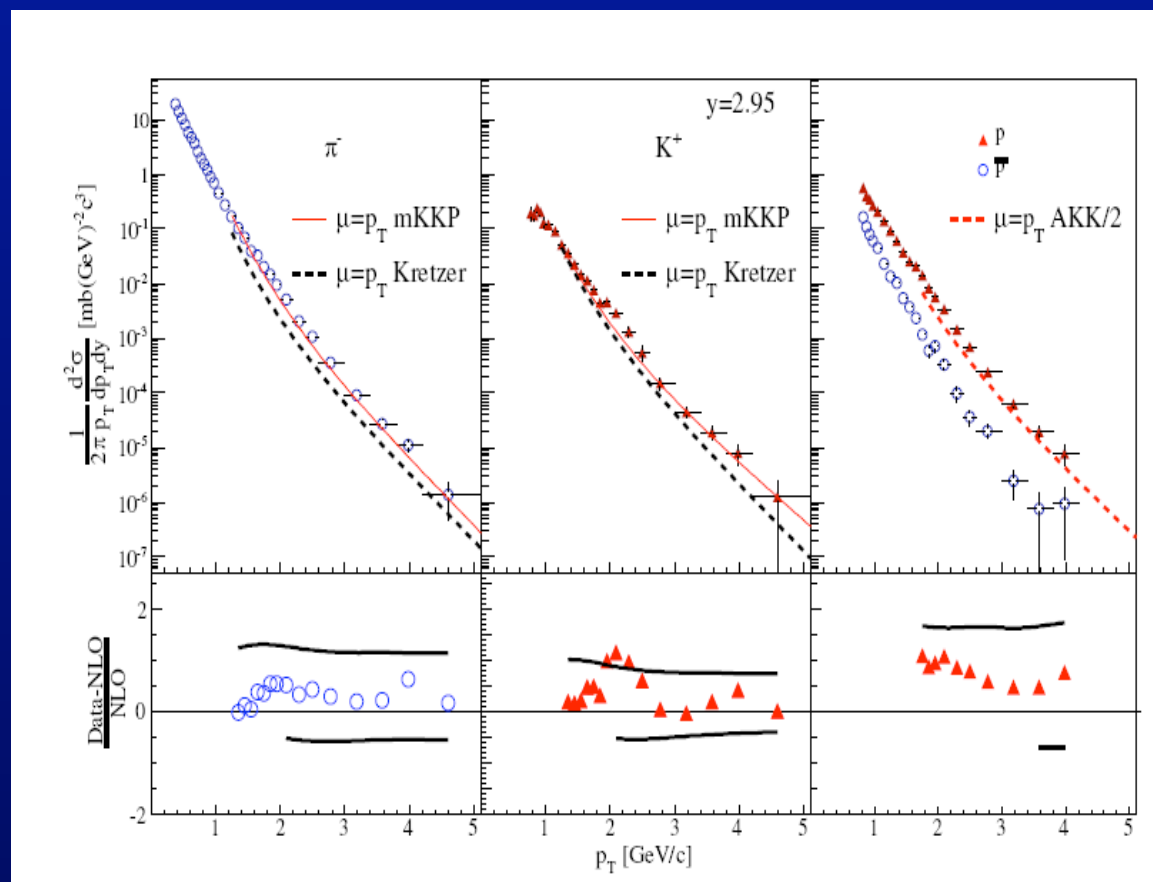
# Un-polarized Cross-sections at



Good description at 200 GeV over all rapidities down to  $p_T$  of 1-2 GeV/c.

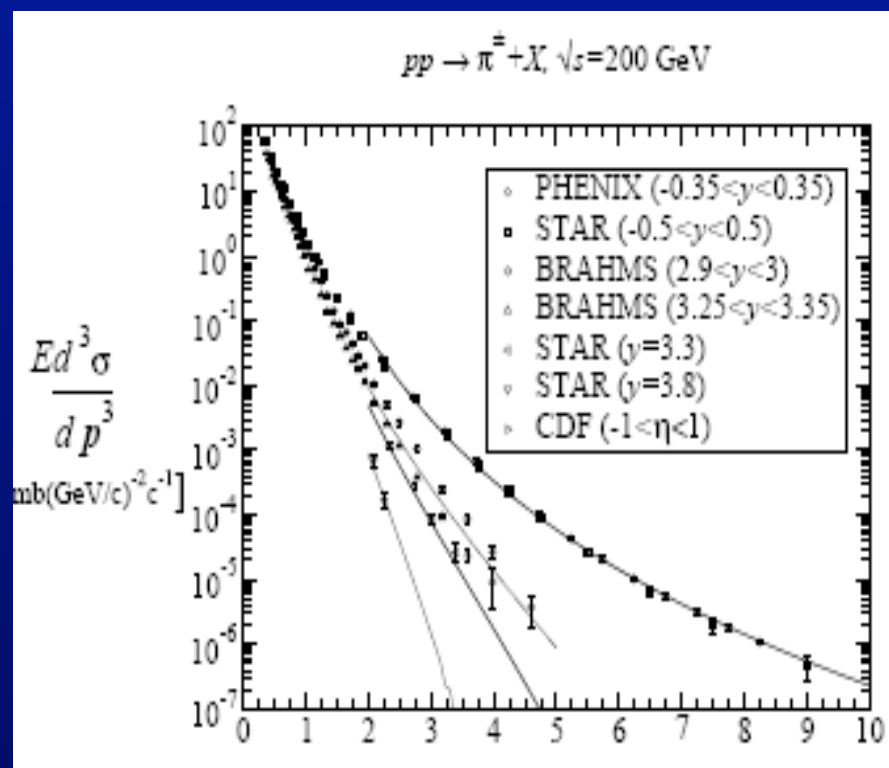


# Brahms when first published

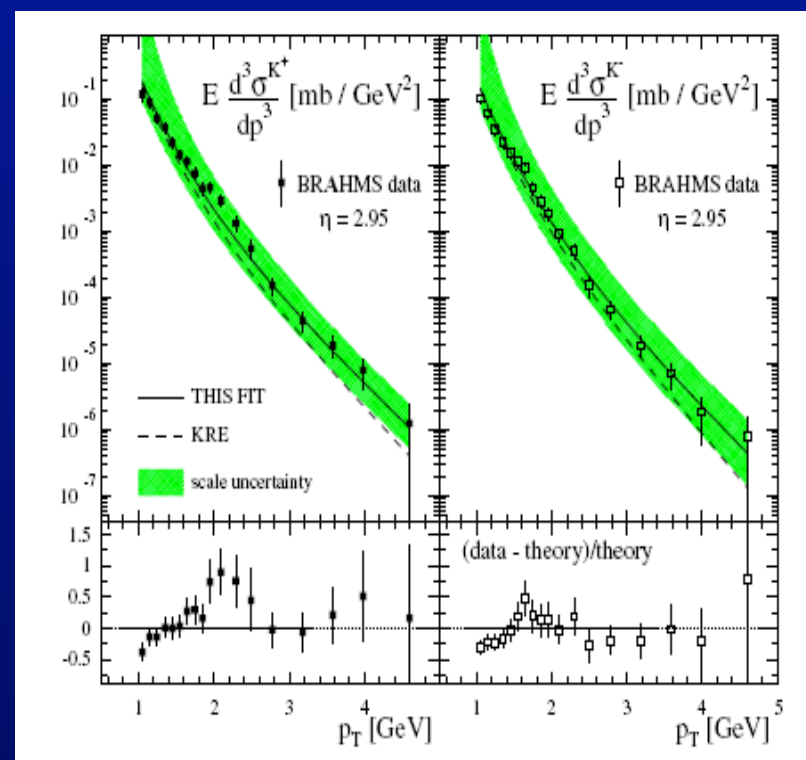


## Charged separated fragmentation function

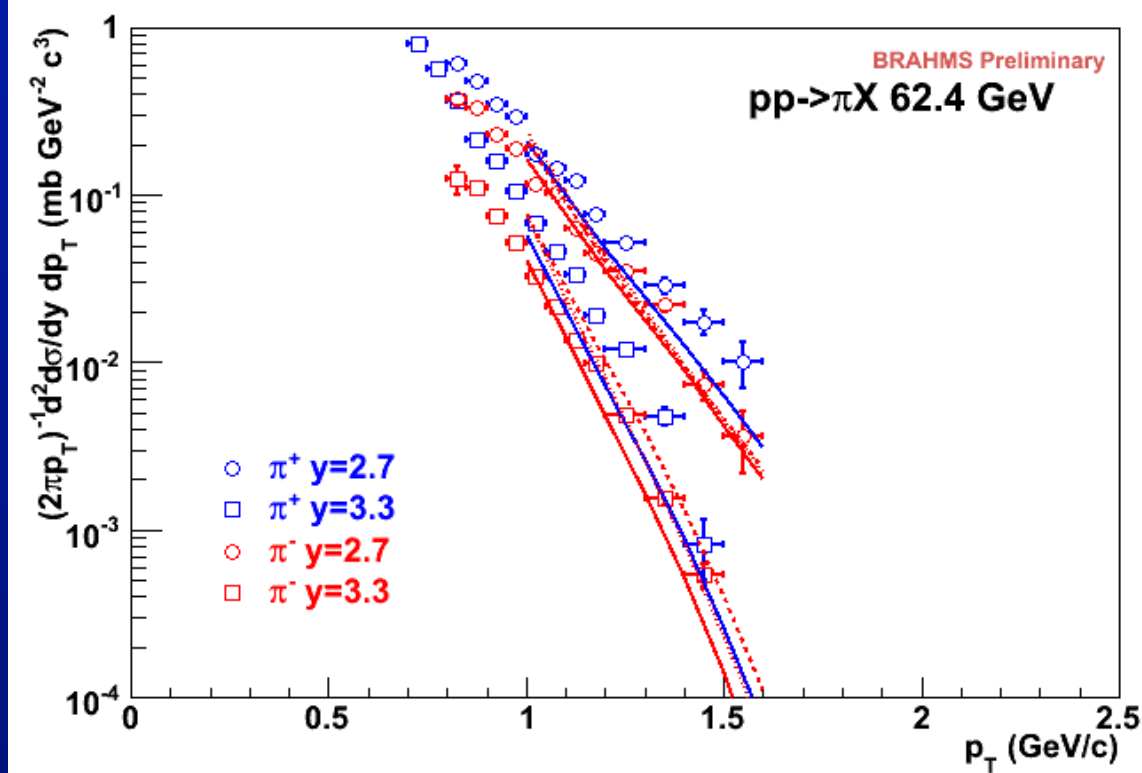
Recently deFlorian, Sassot and Stratman performed a global fit including new data from Brahms at high rapidity. PRD 75, 114010 (2007)



AKK



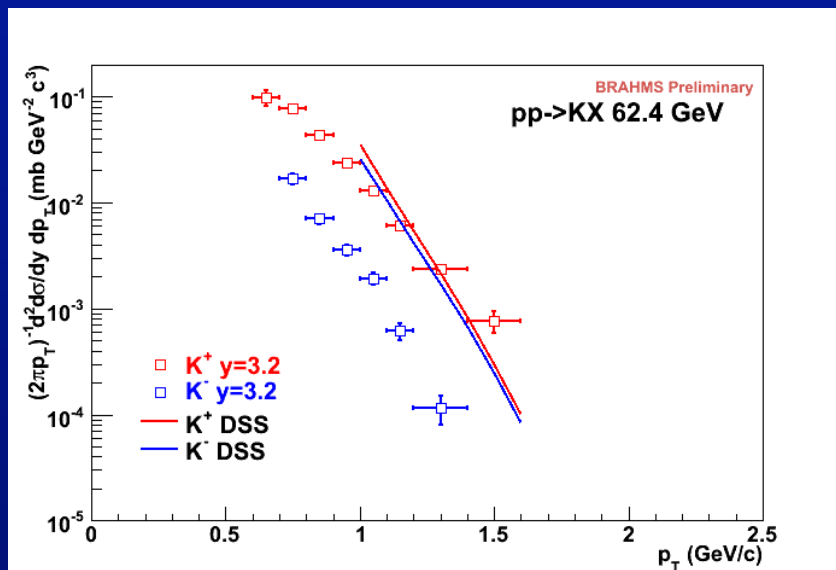
Brahms data: PRL 98, 252001 (2007)



Comparison of NLO pQCD calculations (Vogelsang) with BRAHMS  $\pi^-$  data at high rapidity. The calculations are for KKP (solid) and a scale factor of  $\mu=p_T$ , DSS with CTEQ5 and CTEQ6.5 are also shown.

The agreement is surprisingly good, in apparent disagreement with earlier analysis of ISR  $\pi^0$  data at 53 GeV.

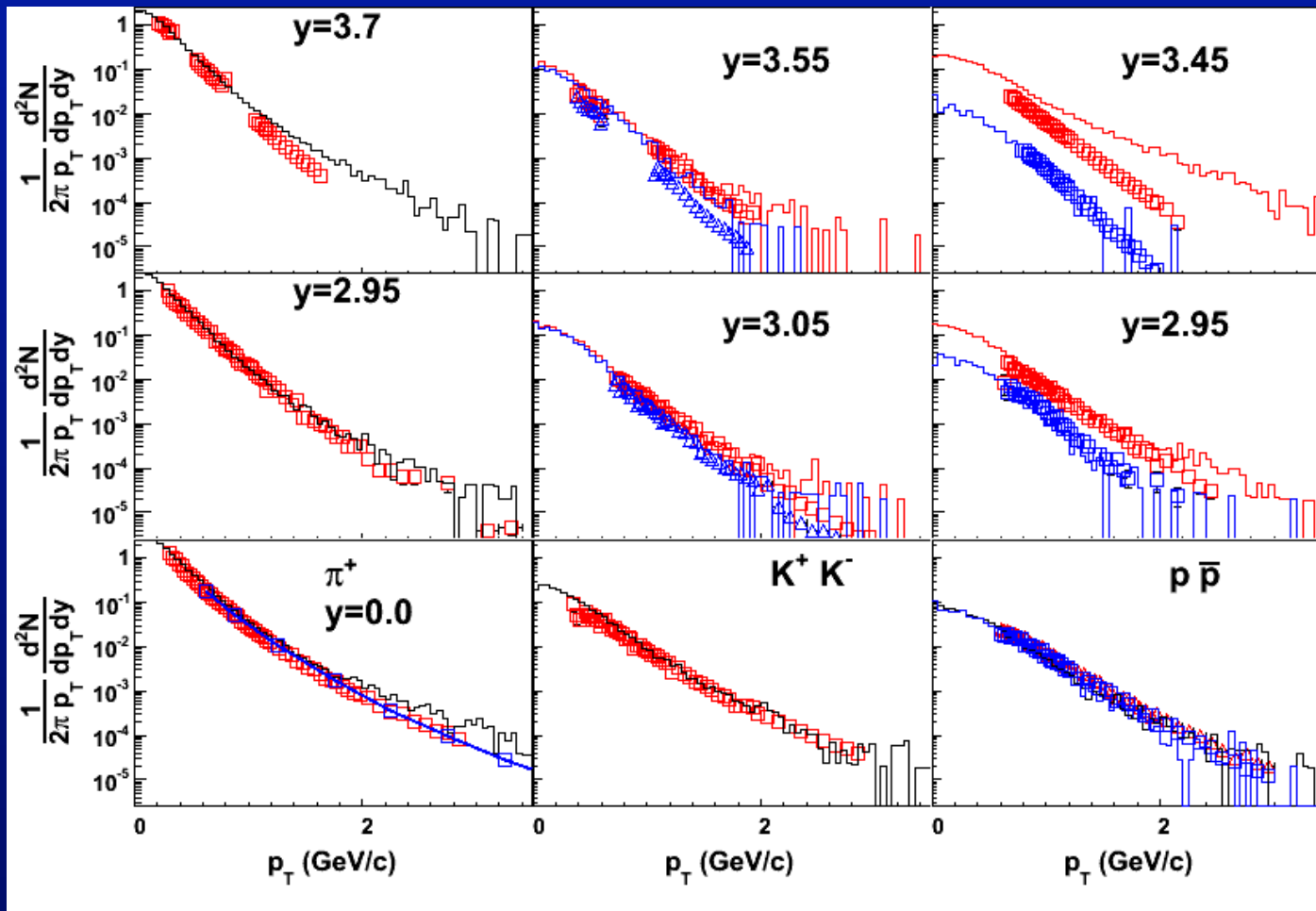
# Kaon 62 GeV at $y=3.2$



The K- data are suppressed due order of magnitude (valence quark effect).  
NLO pQCD using the recent DSS fragmentation functions give approximately same yield (?) Related to fragmentation or PDFs?

The DSS fragmentation were *tuned* to the BRAHMS data from 200 GeV at 2.95 at 3.3 rapidity but apparently fails at lower energy. Of course there is a limit to how low one would trust pQCD in energy.

# PYTHIA 6.4– 200 GeV data



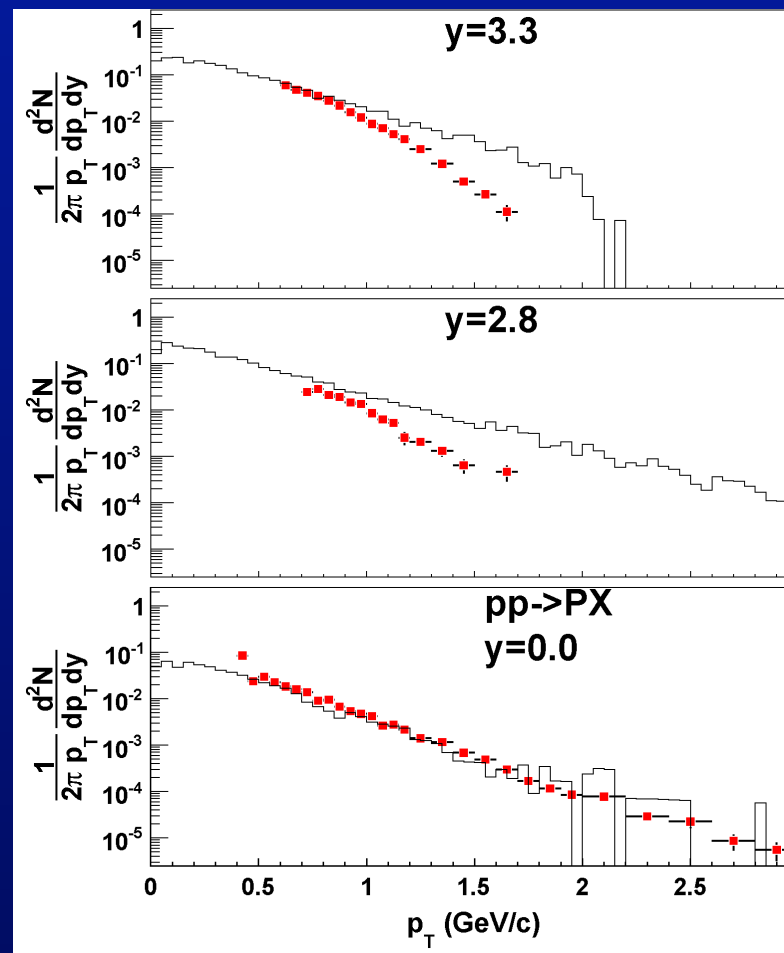
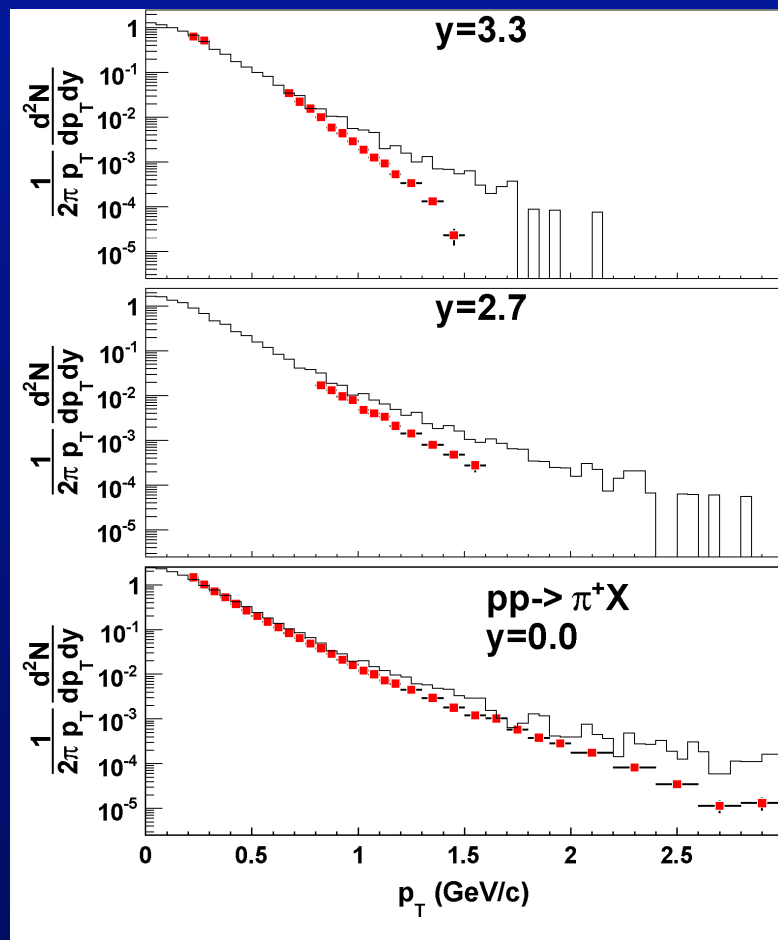
Overall good agreement for pions, kaons

High rapidity protons (large  $p_T$ ) –

K-/K+ at highest rapidity - also an issue in NLO pQCD

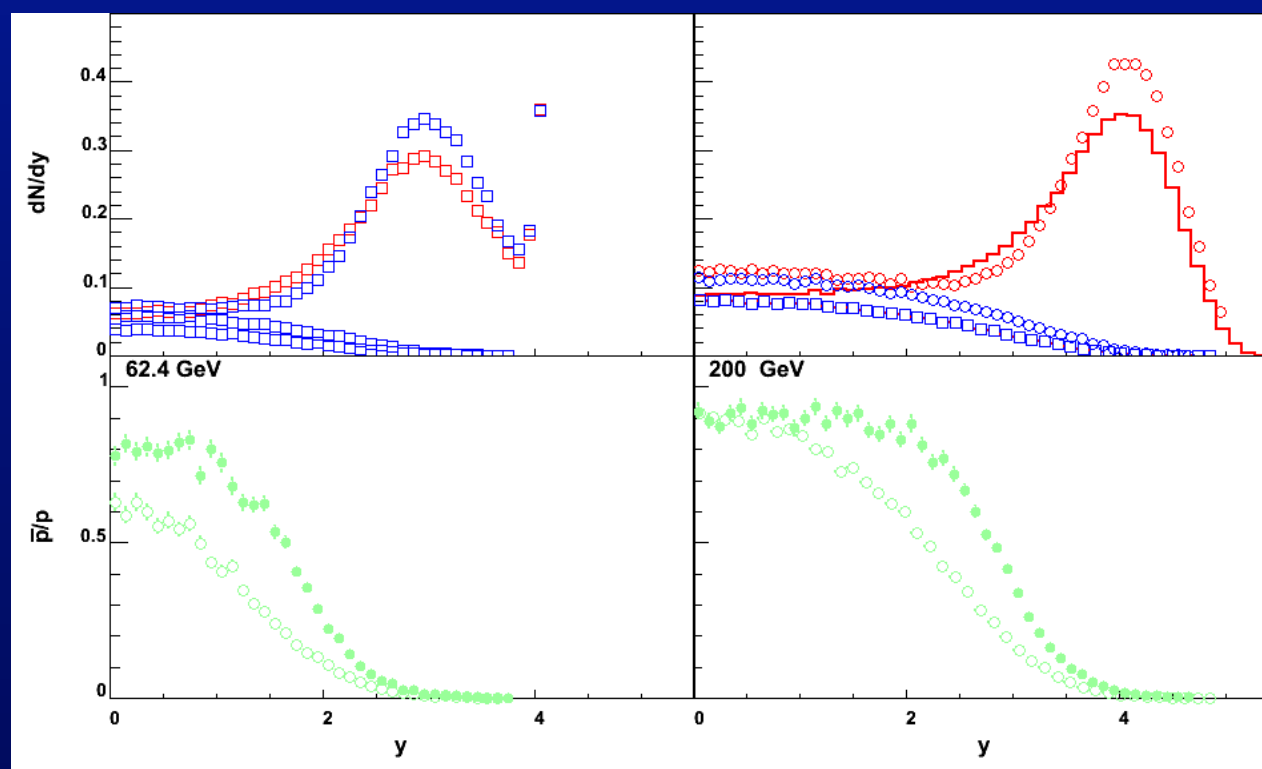
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62.4 GeV seems to have similar discrepancies as 200 but more pronounced at high  $y$ .



# Baryon mechanism (Eden et al)

- The  $\bar{p}/p$  at 62 gev much closer to data with this mechanism.





# Take away messages

- The RHIC 200 and 62 GeV data add significant data that should be understood in terms of underlying event.
- The BRAHMS data are unique in having identified yields at high rapidities, probing high  $x_F$  and  $z$ .
- We are also looking into the multiplicity dependence at 200 and 62 GeV